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Interaction of credit and liquidity risks: Modelling and valuation

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Abstract

In this paper we discuss the interaction of default risk and liquidity risk on pricing financial contracts. We show that two risks are almost indistinguishable if the underlying contract has non-negative values; however, if it can take both positive and negative values then these two risks demand different risk premiums depending on their loss rates and distributions. We discuss a structural default model and a discrete time default model with exponentially distributed liquidity shocks. We show that short-term yield spreads are dominated by liquidity risk rather than credit risk. We suggest a two-stage procedure to calibrate the model with one scalar optimization problem and one linear programming problem.

JEL classification: C51; C61

Keywords: Default risk; Liquidity risk; Conditional independence; Structural and intensity models; Calibration with two-stage optimization

1. Introduction

Investors of financial securities face many types of risks. The main ones are market risk, credit risk, and liquidity risk. The market risk is the risk of adverse deviation of the security value due to changes of market conditions, such as changes in stock

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market indexes, exchange rates, and interest rates. The credit risk is either the default risk or the credit migration risk. The former refers to that a counterparty may fail to comply with its obligations. The latter refers to that the credit spread may change due to changes in the credit quality of a counterparty over time. The migration risk is irrelevant if one takes the buy-hold policy, and the only credit risk in that case is the default risk. The liquidity risk is characterized by the inability of selling (or buying) an asset in a timely and cost-effective manner, which can be measured by bid–ask spreads. Much financial mathematics literature has been focused on identifying and quantifying these risks for the purposes of valuation and hedging.

There has been extensive research literature on market risk and its impact on pricing and hedging financial derivatives, see Duffie (2001) and Hull (2002) and numerous references cited within. The credit risk has attracted great attention in recent years due to increasing market uncertainty and vulnerability and some high profile defaults. Many credit risk models have been suggested for pricing and hedging credit risky securities. These models can be broadly classified as either structural models (Black and Scholes, 1973; Merton, 1974; Black and Cox, 1976; Longstaff and Schwartz, 1995) or intensity models (Jarrow and Turnbull, 1995; Duffie and Singleton, 1999).

The structural models assume that firm assets follow some log-normal processes and the default is triggered when firm assets fall below a threshold level, called a default barrier, so equity is a call option on assets. The approach has appealing economic interpretations and is easy to compute implied default probabilities, yield spreads, and recovery rates, however, it has difficulty in producing realistic yield spreads of short-term defaultable securities. Great efforts have been made to remove this limitation, for example, assets are modelled with jump-diffusion processes (Zhou, 2001), or default barriers are driven by unobservable random variables and are unknown until the default has happened (Finger, 2002; Duffie and Lando, 2001; Giesecke, 2003).

The intensity models typically assume that the default time indicator follows some point process that admits an intensity process. If the indicator is a Poisson process, the default time is exponential. If the indicator is a Cox process, i.e., conditional on the realization of intensity process, the indicator is an inhomogeneous Poisson process, the default time is conditionally exponential. The intensity approach uses the information of yield spreads from the market to extract default probabilities and is useful to compare prices of credit derivatives, however, it is unable to explain reasons of defaults or to provide views contrary to the market. Intensity models in general deal with aggregate yield spreads and do not separate different forms of risks (e.g., credit risks vs. liquidity risks).[1] See Duffie and Singleton (2003) and Schonbucher (2003) for recent surveys on credit risk modelling, pricing and implementation.

In contrast to market and credit risks, the liquidity risk has been largely unexplored. There is no commonly agreed definition for liquidity measure yet. Some people use direct measures such as bid–ask spreads, trade sizes and frequencies. Others

[1] A recent paper by Jarrow (2001) suggests an intensity model that incorporates both credit and liquidity risks where the liquidity premium is interpreted as a convenience yield which can be positive or negative depending on whether the underlying defaultable security is in a shortage or in a glut.